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(54) Abstract Title
Two-stroke engine with forward scavenging air positioning and single-flow carburettor

(57) A two-stroke engine 1 with forward scavenging air positioning of the type used as a drive engine in manually operated tools, in which the mixture is sucked into the crankcase 4 via a throttle valve carburettor 17 and fed into the combustion chamber 3 via transfer passages 12, 15 formed in the cylinder 2. An air duct 8 is connected to a transfer passage 12, 15 via a controllable connection 14, 39 in order to convey essentially fuel-free air into the transfer passage 12, 15 in a load state of the two-stroke engine 1. To be able to convey a volume of fuel adapted to the volume of air sucked in at idle and part throttle whilst still achieving a separate feed supply of air and mixture at full throttle, a dividing wall 31 extending in the direction of flow 26 of the air is provided in the intake duct 22 of the carburettor 17. In the dividing wall 31 in the area of the throttle valve 24 is provided a connecting aperture 34 which is closed at full throttle by the fully opened throttle valve 24. At idle and part throttle, on the other hand, the connecting aperture 34 is open, allowing even pressure to build up in the intake duct 22 in accordance with the volume of air sucked in.

Fig. 1

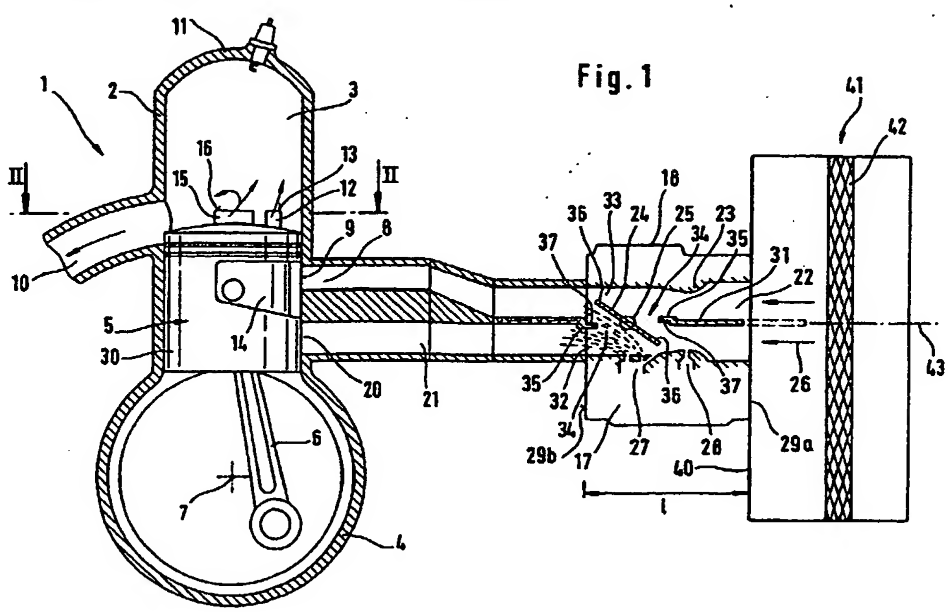

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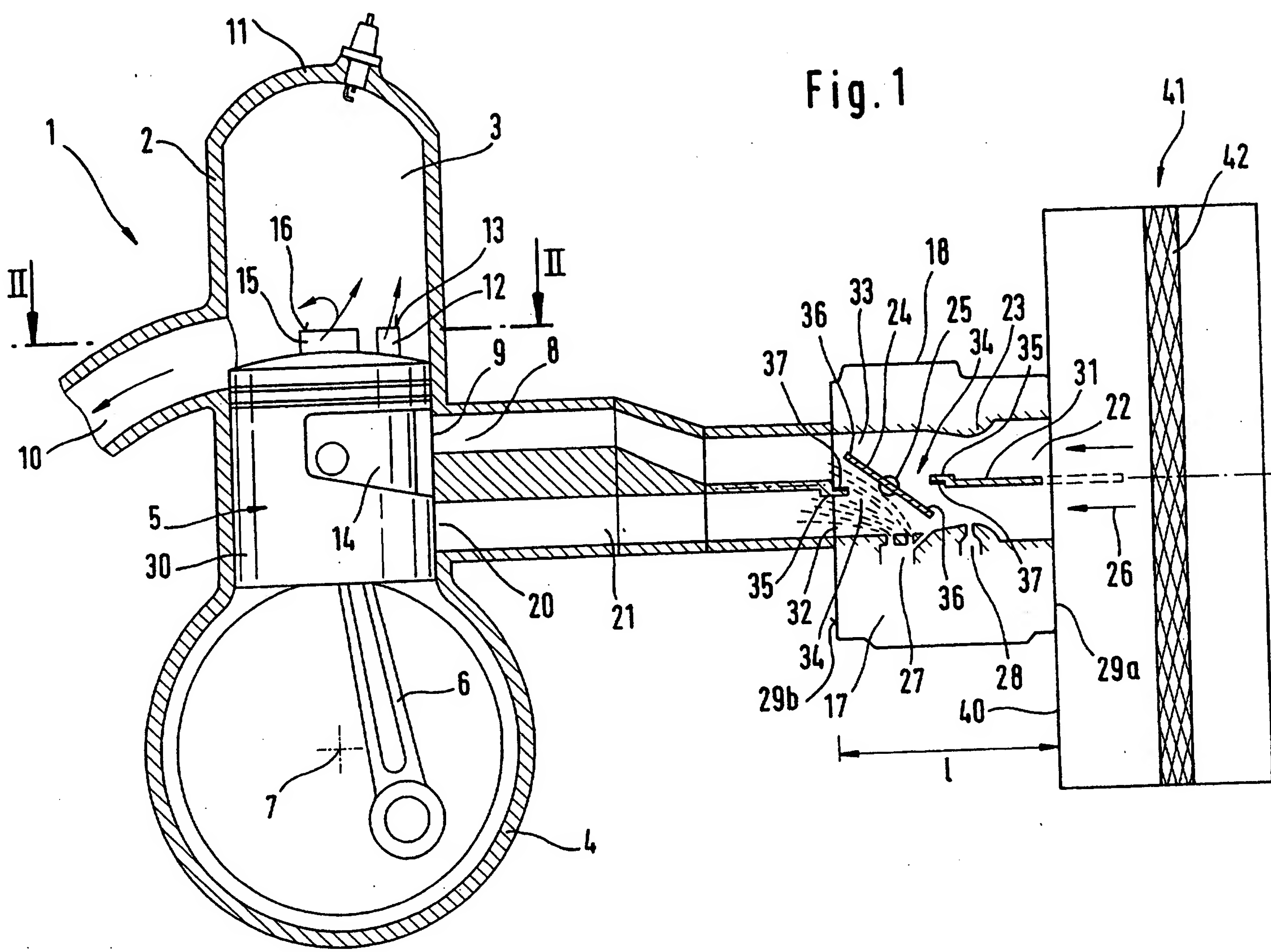
Fig.1



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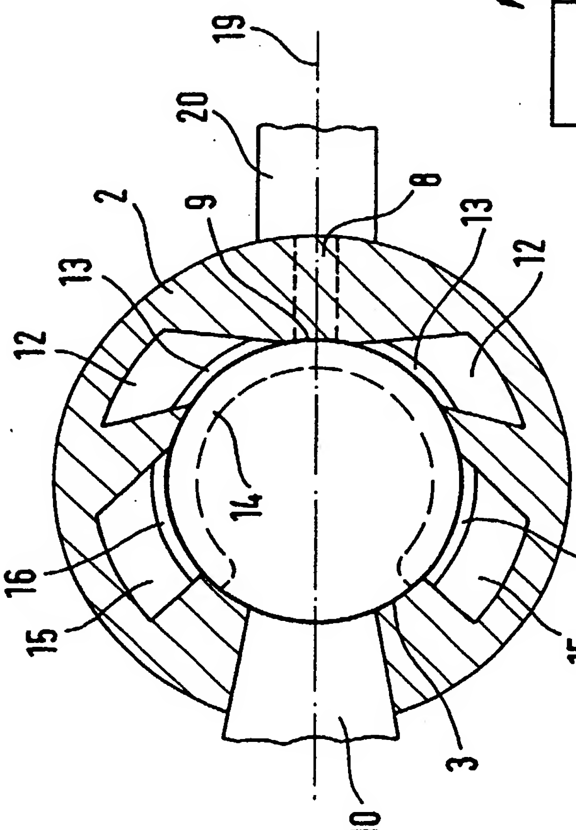

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Fig. 2

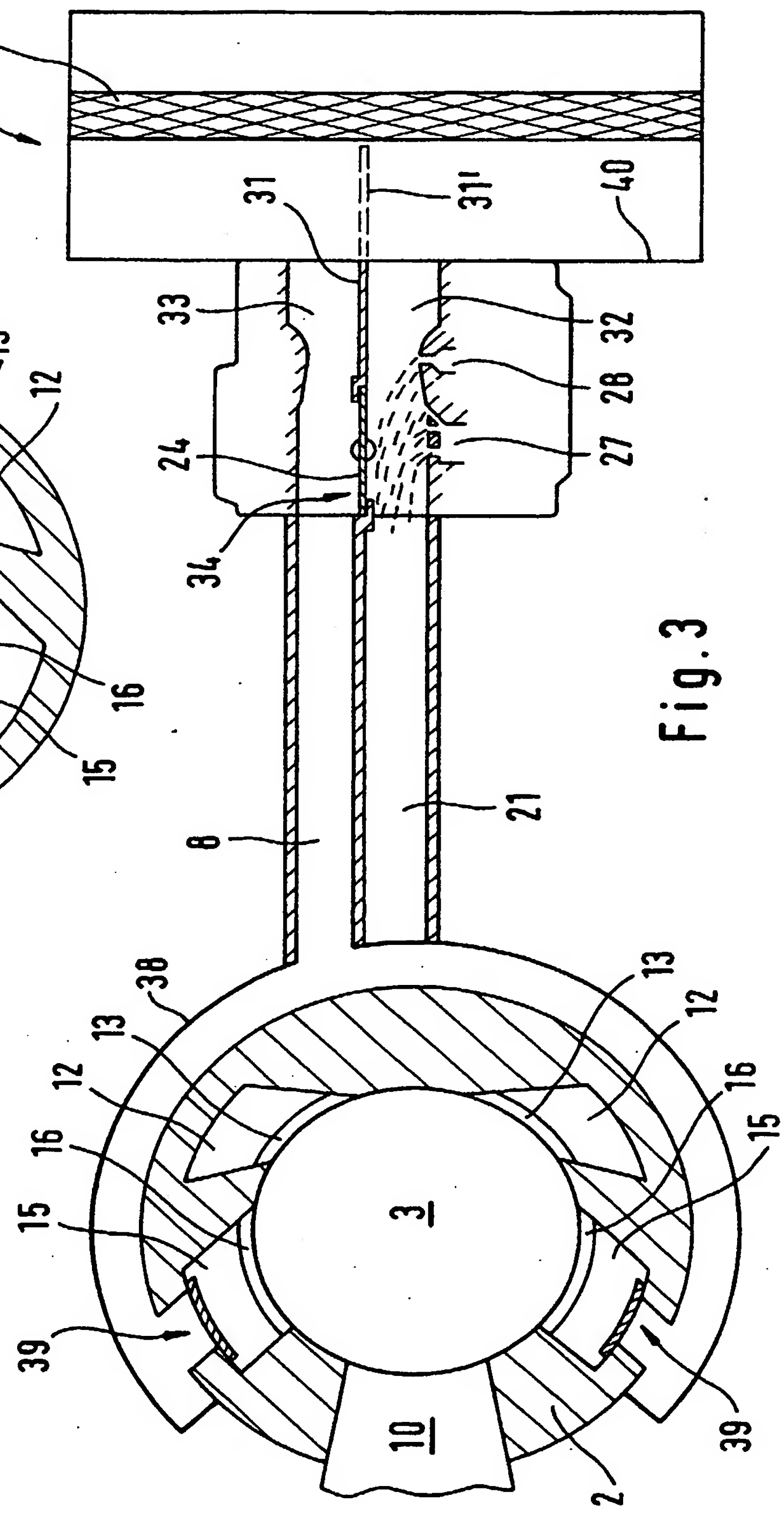

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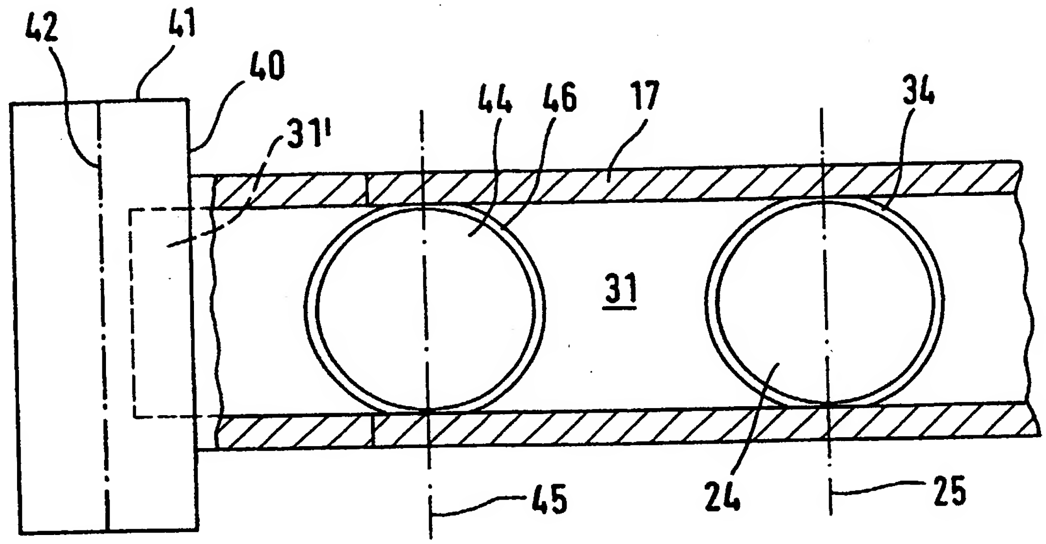
Fig. 3

Fig. 4



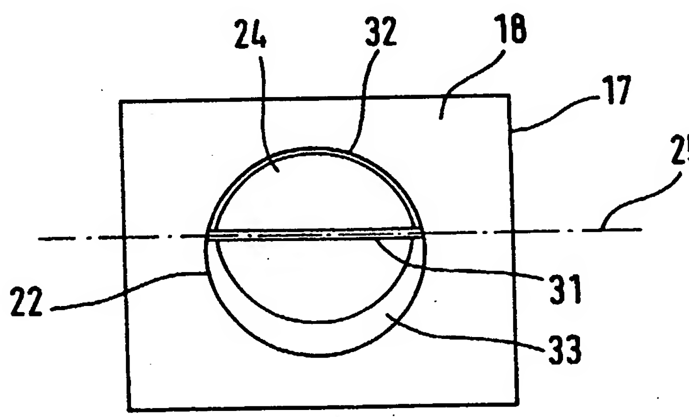


Fig. 5

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Two-stroke engine with forward scavenging air positioning and single-flow carburettor

The invention relates to a two-stroke engine, particularly but not exclusively for use as a drive engine in a manually operated, portable tool such as a chain saw, brush cutter, parting-off grinder or the like.

A two-stroke engine of this type is known from DE 199 00 445 A1. The combustion space formed in the cylinder is connected to the crankcase via transfer passages, the mixture required for combustion being conveyed to the crankcase. In order to ensure that as little uncombusted fuel as possible is lost through the exhaust during the scavenging of the combustion space, the transfer passages close to the exhaust are connected to an air duct and fuel-free air is sucked in through the transfer passages during the intake stroke. The air is then held at the front of the transfer passages and enters first the next time the mixture transfers into the combustion space. The mixture flowing out of the crankcase follows some time later and the scavenging losses flowing out of the exhaust during the scavenging of the combustion space come largely from the forward positioned scavenging air.

In practice, a number of problems occur during the metering of the fuel required to operate the internal combustion engine by a carburettor. For example, at idle it is necessary to guarantee that the air duct is fully closed in order to prevent the idle mixture becoming too lean in an uncontrolled manner in the combustion space as a result of the air flowing into it. During acceleration, too, the opening of the air duct renders the mixture too lean as a result of which the speed of the internal combustion engine increases only reluctantly to the desired level.

On the other hand, it is important to guarantee that the air duct remains as free as possible from fuel at full throttle in order that the significant reduction in exhaust gas emissions which the forward positioned scavenging air is designed to achieve can be obtained.

The present invention seeks to provide a two-stroke engine of the known type in such a manner that it is possible to reliably prevent the mixture in the combustion space becoming too lean at idle and part throttle whilst retaining the advantageous effects of the supply of fuel-free air with which to scavenge the combustion space at full throttle.

According to the present invention there is provided a two-stroke engine, for use as a drive engine in a manually operated, portable tool, with a combustion space which is formed in a cylinder and delimited by a reciprocating piston, the piston, via a connecting rod, driving a crankshaft rotatably mounted in a crankcase, with an air/fuel inlet issuing into the crankcase which is connected to an intake duct section, which has a cross-section which can be modified by means of a throttle valve, of a carburettor via which a fuel/air mixture is sucked into the crankcase, the throttle valve lying generally at right angles to the longitudinal centre line of the intake duct section when the two-stroke engine is at idle and generally parallel to the longitudinal centre line at full throttle, with a transfer passage which connects the crankcase to the combustion space and the end of which facing the cylinder head issues via a transfer port controlled by the piston into the combustion space, the transfer port being open in a lower position of the piston and closed in an upper position of the piston, and the end of the transfer passage facing the crankcase being open to the crankcase in both the upper and lower piston positions, with an air duct which is connected via a controllable connection to the transfer passage in the area of its cylinder-head end in order to convey essentially fuel-free air to the transfer passage in a load state of the two-stroke engine and with an exhaust which conveys exhaust gases away from the combustion space, wherein the intake duct of the carburettor is divided by a dividing wall extending in the direction of flow, one part of the duct featuring fuel feeders forming the intake duct section and the other part of the duct forming the air duct, the dividing wall extends substantially along the entire length of the intake duct from one front face of the carburettor body to its other front face, a connecting aperture is formed in the dividing wall in the area of rotation of the throttle valve, and when the two-stroke engine is operating at full throttle the connecting aperture is essentially closed by the fully opened throttle valve in such a

manner that the air duct and the intake duct section are effectively separated from one another at full throttle.

The dividing wall in the intake duct of the carburettor divides the venturi along its longitudinal centre line into a section of the intake duct and an air duct. Here the dividing wall is essentially provided along the entire length of the intake duct from one front face of the carburettor body to its other front face in such a manner that even fuel precipitating due to return pulsation upstream of the throttle valve is unable to simply pass into the air duct. At full throttle the throttle valve closes the connecting aperture in the dividing wall in such a manner that the dividing wall, which extends as far as the upstream front face, opposes any transfer of fuel upstream of the throttle valve. The dividing wall extends preferably as far as the base of an air filter fitted upstream of the carburettor, usefully into the air filter housing and in particular as far as the filter element itself. The extension of the dividing wall upstream of the throttle valve into the filter housing achieves a functional division of air duct and mixture duct on the intake side.

The design disclosed in the invention ensures that the pressure prevailing in the venturi at idle and part throttle corresponds to the joint pressure in the air duct and the mixture duct. The volume of fuel conveyed into the venturi in accordance with this joint underpressure is thus proportional to the volume of air conveyed, irrespective of whether it is conveyed to the combustion space via the mixture duct or the air duct. This prevents the mixture becoming too lean at both idle and part throttle.

Similarly, if a choke valve is fitted this arrangement guarantees that the underpressure prevailing due to the adjustment of the choke is the same throughout the entire system in such a manner that under choke conditions, too, a volume of fuel adapted to the volume of air sucked in is conveyed and mixed with the air.

In order to achieve a dry, i.e. largely fuel-free, air duct at full throttle, the aperture edge of the connecting aperture and the edge of the valve overlap. Here the overlapping

aperture edge can be designed as a seat for the edge of the valve and the aperture edge can also have a seal.

Further features of the invention are detailed in the further claims, the description and the drawings which illustrate embodiments of the invention described individually below.

Fig. 1 shows	a schematic view of a two-stroke engine with port-controlled forward scavenging air positioning and a single-flow carburettor.
Fig. 2 shows	a schematic section along the line marked II-II in Fig. 1.
Fig. 3 shows	a schematic view of a the section of a membrane-controlled system with forward scavenging air positioning as illustrated in Fig. 2.
Fig. 4 shows	a schematic sectional view through a carburettor with a throttle valve and a choke valve.
Fig. 5 shows	a schematic view of the front face of a carburettor with an eccentrically positioned throttle shaft.

The two-stroke engine 1 illustrated schematically in Fig. 1 is used as a small-volume drive engine preferably in manually operated, portable tools such as, for example, chain saws, brush cutters, parting-off grinders, etc. The displacement of an internal combustion engine of this type lies typically within a range of 18 cm^3 and 500 cm^3.

The two-stroke engine 1 has a cylinder 2 in which is provided a combustion space 3 which is delimited by a reciprocating piston 5. Via a connecting rod 6, the piston 5 drives a crank shaft 7 which is mounted in a crankcase 4 in such a manner that it can rotate.

An inlet 20 controlled in the embodiment illustrated by the piston skirt 30 issues into the crankcase 4. In the embodiment shown, the inlet 20 is therefore opened and closed

dependent upon the stroke position of the piston 5. It can be useful to provide a membrane control system instead of the piston port control system illustrated. The inlet 20 then issues into the crankcase 4 outside the piston stroke area, it being necessary to position a membrane valve which opens in the direction of the crankcase 4 in the inlet 20. The opening of the inlet 20 is then controlled by underpressure.

The crankcase 4 is connected to the combustion space 3 via transfer passages, these transfer passages – cf. Fig. 2 – being designed as straight or handle-shaped passages in the side wall of the cylinder. In the version illustrated, a first pair of transfer passages 12 and second pair of transfer passages 15 are provided, one of each pair being on either side of a plane of symmetry 19. The second pair of transfer passages 15 are located close to an exhaust 10 which conveys exhaust gases out of the combustion space 3 and are also referred to as exhaust transfer passages 15. The first pair of transfer passages 12 are positioned some distance from the exhaust 10 and are referred to as exhaust-distant transfer passages 12. As illustrated in the section shown in Fig. 2, the plane of symmetry 19 divides the cylinder 2 into symmetrical halves and runs roughly centrally through the exhaust 10/inlet 20.

The end of each transfer passage 12, 15 facing the cylinder head 11 issues into the combustion space via a transfer port 13, 16. The transfer ports 13, 16 are controlled by the piston 5 as it rises and falls, the transfer ports 13, 16 being open in a lower piston position close to bottom dead centre (BDC) illustrated in Fig. 1 and being closed in an upper piston position between BDC and top dead centre (TDC). The ends of the transfer passages 12, 15 facing the crankcase 4 are open in both the lower and the upper piston positions.

Furthermore, the transfer passages 12, 15 can also be connected to an air duct 8 which issues into an air port 9 in the wall of the cylinder 12. A connecting port 14 is formed in the piston skirt 30 at the level of the air port 9 which, as illustrated in Fig. 2, extends from the air port 9 opposite the exhaust 10 in both directions around the circumference of the piston covering an angle at circumference of some 120° such that in the corresponding piston stroke position the transfer ports 13 and 15 communicate with the

connecting port 14, the connecting port 14 being designed such that it also connects with the air port 9 of the air duct 8 in this piston stroke position. Thus, when the piston 5 rises towards TDC, a connection is made between the air duct 8 and the transfer ports 13 and 15 and the underpressure prevailing in the crankcase 4 at the time is sucked out of the air duct 8 through the transfer passages 12 and 15.

The air duct 8 and an inlet duct 21 leading to the inlet 20 are connected separately to a mixture formation device which is a carburettor 1 in the embodiment shown. The carburettor 17 is usefully a membrane carburettor of the type predominantly used in drive engines in portable, manually operated tools. In the carburettor body 18 is a joint intake duct 22 with a venturi 23. Also positioned in the intake duct 22 is a throttle valve 24 which is mounted on a throttle shaft 25 in the carburettor body 18 in such a manner that it is able to rotate. The common intake duct 22 is divided by means of a dividing wall 31 which extends along the longitudinal centre line 43 in the direction of the air flow 26. The fuel feeders, in the embodiment illustrated idle jets 27 and a main fuel jet 28, are located on one side of the dividing wall which extends essentially from one front face 29a to the other front face 29b of the carburettor body 18 along the entire length 1 of the intake duct 22. Here the part of the duct which contains the fuel feeders 27, 28 forms an intake duct section 32 which is connected to the inlet duct 21. The other part of the duct forms an air duct 22 which is connected to the air duct 8 of the air port 9. In the area of rotation of the throttle valve 24 is a connecting aperture 34 in the dividing wall 31 which forms a connection between the intake duct section 32 and the air duct 33. This connection creates identical pressure conditions on both sides of the dividing wall 31 when the connecting aperture 34 is open. When the connecting aperture 34 is open, the membrane carburettor 17 therefore conveys a volume of fuel which is always proportional to the volume of air sucked in via the jets 27 and 28.

In the part throttle position illustrated in Fig. 1, the throttle valve is located half open at right angles to the longitudinal centre line 43 in the intake duct, the axis of rotation of the throttle valve being located exactly in the plane of the dividing wall 31. In this throttle valve position, the connecting aperture 34 is partially open and the fuel sucked in through the fuel jets 27 therefore enters both the intake duct section 32 and the air

duct 33 via the open connecting aperture 34. At idle and/or part throttle, both the air duct 8 and the inlet port 21 therefore convey a fuel/air mixture, it being possible, due to the arrangement of the jets in the intake duct section 32, for the fuel/air mixture conveyed in the inlet duct 21 to be richer than that conveyed in the air duct 8 into which fuel is only allowed to enter via the partially opened connecting aperture 34.

Downstream of the carburettor 17 the intake duct section 32 is connected to the inlet 20 via the inlet duct 21 and the air duct 33 is connected to the air port 9 via the connecting duct 8. Downstream of the carburettor 17 the air ducts 8, 33 therefore run separately from the mixture ducts 21, 32.

When the internal combustion engine is in operation, as the piston 5 rises towards TDC the transfer ports 13 and 16 and the exhaust 10 are closed. The rising piston 5 opens the inlet 20 and at the same time or a few crank angle degrees later connects the air port 9 to the transfer ports 13 and 16 via the connecting port 14. Thus at the same time as the air duct 8 is connected to the transfer passages 12, 15 or slightly earlier, the inlet 20 to the crankcase 4 is opened, allowing the mixture to flow into the crankcase 4. When the air port 9 of the connecting port is connected to the transfer windows 13, 16, low-fuel mixture or largely fuel-free air is sucked in and flows down through the transfer ports 13, 16 to the crankcase 4. The transfer passages 12 and 15 thus fill with lean mixture or with largely fuel-free air, the transfer passage 15 close to the exhaust preferably being filled with air.

Following ignition, the piston 5 descends to BDC again, the flow connection between the transfer passages 12, 15 and the air duct 8 being interrupted and the inlet 20 being closed. Since the piston 5 is descending, the mixture sucked into the crankcase 4 is compressed and, as the piston-controlled transfer ports 13, 16 are opened, flows into the combustion space 3, filling it with fresh mixture for the next compression stroke. Here the low-fuel or fuel-free air is positioned forward of the rich mixture in the crankcase 4 and scavenging losses flowing out through the open exhaust 10 are therefore largely formed by the low-fuel mixture and the fuel-free air.

At full throttle, the throttle valve 24 is fully open as illustrated in the example of a membrane-controlled forward scavenging air positioning system shown in Fig. 3. When the throttle valve 24 is fully open it lies roughly parallel to the longitudinal centre line 43 to essentially close the aperture 34 such that the air duct 33 and the intake duct section 32 are effectively separate from each other although a degree of leakage may be permitted to enable pressure equalisation between the two ducts. To completely close the aperture 34, in this embodiment, the throttle valve 24 preferably seals the connecting aperture 34. In order to achieve this, the connecting aperture 34 is designed with a slightly smaller throughput section than that of the valve 24 itself. The aperture edge 35 of the connecting aperture 34 and the edge 36 of the throttle valve 24 overlap one another, thereby achieving a sealed fit. Here the aperture edge 35 is usefully designed as a seat for the edge 36 of the valve, the aperture edge 35 usefully bearing a seal 37. The seal is preferably a rubber seal which may be provided in the form of a gasket or a tied-in seal. This ensures that the air duct 8 is dry, i.e. free of fuel, at full throttle and thus that scavenging losses which occur during the scavenging of the combustion space 3 comprise exclusively of fuel-free air.

In order to guarantee that the air duct 8/33 remains free of fuel at full throttle, the dividing wall 31 is designed to extend upstream of the carburettor 17 as far as the base 40 of an air filter 41. If the dividing wall 31' is taken into the air filter housing, preferably extended into the area of the filter element 42, it is possible to prevent fuel precipitating in the air filter 41 as a result of air pulsation in the intake train from transferring to the air duct 33.

While in the embodiment illustrated in Figs. 1 and 2 the connection between the air ducts 8, 33 and the transfer passages are controlled by piston ports, Fig. 3 shows a connection between the air duct 8 and at least the transfer passages 15 close to the exhaust port via a distributor duct 38 and a non-return valve which is designed as a reed valve 39 in this embodiment. The distributor duct 38 can be designed as an external duct, a hose connection or a duct integrated into the cylinder 2. As the piston 5 rises, underpressure is created in the crankcase 4 and also in the transfer passages 12, 15 due to the fact that these transfer passages 12, 15 are open to the crankcase 4. Due to the

pressure difference thus created at the reed valve 39, the reed valve 39 opens and low-fuel mixture/fuel-free air is sucked into the transfer passage 15 close to the exhaust via the reed valve 39. As the piston 5 descends, the overpressure which builds up in the crankcase 4 closes the reed valve 39. It can also be useful to connect the transfer passages 12 to the air duct via a non-return valve such as a membrane valve, e.g. via a controlled connection to the distributor duct 38.

In the embodiment illustrated in Fig. 4, a choke valve 44 is provided upstream of the throttle valve 24 which is mounted on a choke shaft 45 in the carburettor 17 or the carburettor body 18 in such a manner that it can rotate. The choke shaft 45 is located in the plane of the dividing wall 31/31'. The choke valve 44 is associated with a further connecting aperture 46 in the dividing wall 31, when the choke valve 44 is in the open position illustrated in Fig. 4 the further connecting aperture 46 being largely closed by the choke valve 44. Here it is possible to provide sealing measures such as those which have already been described in relation to the throttle valve 24. This design guarantees that when the choke and the partially opened throttle valve 24 are actuated, the higher intake underpressure produced takes effect in both the air duct and the mixture duct, the pressure conditions in the venturi are therefore identical and a volume of fuel proportional to the volume of air sucked in is metered.

It can be useful to position the dividing wall 31, 31' in the carburettor body 18 eccentrically in relation to the intake duct 22 thereby giving the air duct 33 and the mixture duct 32 different cross sectional areas. In this case, the throttle shaft 25 and a choke shaft 45 continue to be located approximately in the plane of the dividing wall 31, but slightly offset towards the centre of the intake duct 22 as shown in Fig. 5. The ratio A/L between the cross sectional area of the intake duct section 32 and the cross sectional area of the air duct 33 lies roughly within a range of 0.5 to 1.9 and preferably within a range of 0.54 to 1.86. This means that the cross sectional area of the air duct can be between 65% and 35% of the total cross sectional area of the intake duct 22.

Claims

1. A two-stroke engine, for use as a drive engine in a manually operated, portable tool, with a combustion space which is formed in a cylinder and delimited by a reciprocating piston, the piston, via a connecting rod, driving a crankshaft rotatably mounted in a crankcase, with an air/fuel inlet issuing into the crankcase which is connected to an intake duct section, which has a cross-section which can be modified by means of a throttle valve, of a carburettor via which a fuel/air mixture is sucked into the crankcase, the throttle valve lying generally at right angles to the longitudinal centre line of the intake duct section when the two-stroke engine is at idle and generally parallel to the longitudinal centre line at full throttle, with a transfer passage which connects the crankcase to the combustion space and the end of which facing the cylinder head issues via a transfer port controlled by the piston into the combustion space, the transfer port being open in a lower position of the piston and closed in an upper position of the piston, and the end of the transfer passage facing the crankcase being open to the crankcase in both the upper and lower piston positions, with an air duct which is connected via a controllable connection to the transfer passage in the area of its cylinder-head end in order to convey essentially fuel-free air to the transfer passage in a load state of the two-stroke engine and with an exhaust which conveys exhaust gases away from the combustion space, wherein
the intake duct of the carburettor is divided by a dividing wall extending in the direction of flow, one part of the duct featuring fuel feeders forming the intake duct section and the other part of the duct forming the air duct, the dividing wall extends substantially along the entire length of the intake duct from one front face of the carburettor body to its other front face, a connecting aperture is formed in the dividing wall in the area of rotation of the throttle valve, and when the two-stroke engine is operating at full throttle the connecting aperture is essentially closed by the fully opened throttle valve in such a manner that the air duct and the intake duct section are effectively separated from one another at full throttle.

2. A two-stroke engine in accordance with claim 1, wherein

an air filter is positioned upstream of the carburettor and the dividing wall extends as far as the air filter base.

3. A two-stroke engine in accordance with claim 1 or 2, wherein the dividing wall extends into the air filter housing.

4. A two-stroke engine in accordance with claim 3, wherein the dividing wall extends into the air filter housing, as far as the area of the filter element.

5. A two-stroke engine in accordance with any one of claims 1 to 4, wherein a choke valve is positioned upstream of the throttle valve and, provided in the dividing wall in the area of the choke valve is a second connecting aperture which is substantially completely closed by the choke valve when the latter is in the open position.

6. A two-stroke engine in accordance with any one of claims 1 to 5, wherein the connecting aperture has a slightly smaller throughput section than the valve.

7. A two-stroke engine in accordance with claim 6, wherein the aperture edge of the connecting aperture and the edge of the valve overlap.

8. A two-stroke engine in accordance with claim 6 or 7, wherein the overlapping aperture edge comprises a seat for the valve edge.

9. A two-stroke engine in accordance with claim 8, wherein the overlapping aperture edge bears a seal .

10. A two-stroke engine in accordance with claim 9, wherein the overlapping aperture edge seal comprises a rubber gasket.

11. A two-stroke engine in accordance with any one of claims 1 to 10, wherein

the dividing wall divides the intake duct in such a manner that the ratio A/L between the cross sectional area A of the intake duct section and the cross sectional area L of the air duct lies within a range of 0.5 to 1.9.

12. A two-stroke engine in accordance with claim 11, wherein the ratio A/L between the cross sectional area A of the intake duct section and the cross sectional area L of the air duct lies within a range of 0.54 to 1.86.

13. A two-stroke engine in accordance with any one of claims 1 to 12, wherein the valve shaft is mounted in the carburettor body eccentrically in relation to the cross-section of the intake duct.

14. A two-stroke engine in accordance with any one of claims 1 to 13, wherein the air duct is connected to the cylinder-head side end of the transfer passage via a non-return valve.

15. A two-stroke engine in accordance with claim 14, wherein the non-return valve comprises a reed valve.

16. A two-stroke engine in accordance with any one of claims 1 to 15, wherein the air duct is connected to the transfer port of the transfer passage via a connecting port provided in the piston, in accordance with the piston stroke position.

17. A two-stroke engine in accordance with any one of claims 1 to 16, wherein the mixture inlet is opened at approximately the same time as and preferably a little earlier than the air duct is connected to the transfer passage.

18. A two-stroke engine in accordance with claim 17, wherein the mixture inlet is opened slightly earlier than the air duct is connected to the transfer passage.

19. A two-stroke engine, for use as a drive engine in a manually operated, portable tool, substantially as described herein with reference to and as illustrated in the accompanying drawing.

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Application No: GB 0228284.6
Claims searched: 1 to 19

Examiner: John Twin
Date of search: 27 May 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1	WO 99/58829 A (Ricardo)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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